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Risk-Based Decision Analysis for Nonproliferation, Arms Control and International Security

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Risk-based decision analysis can play a vital role in establishing arms-control policy and disarmament consensus building. Negotiations amongst the various stakeholders can be promoted by quantitative cost-benefit analysis that incorporates each of their concerns and preferences.

Arms-control agreements can address the supply and control of weaponry, as well as the demand for them. For example, the START agreements restrict the number of deployable nuclear-weapon systems (including delivery systems). Also addressing the supply of assets are discussions on disposing of excess plutonium (Pu) from disassembled nuclear warheads, and the cutoff of fissile-material production (reprocessed Pu and highly enriched uranium). Export controls restrict the flow of assets, while security guarantees, such as provided by the NPT, are meant to reduce the demand for WMD.

Disarmament involves the retirement and conversion of WMD assets. For physical assets, retirement includes the end-of-life-cycle weapon stages of transportation, storage and disassembly. Options for arms-control agreements include not only the technologies for retirement and conversion, but also safeguards and security measures for physical protection, material control, and material accounting. These measures may include technologies and operations such as tags and seals, protective barriers, security-force operations and procedures, personnel screening, detectors, and the like.

Key to the success of a disarmament agreement is establishing confidence in mutual compliance to its terms. Confidence-building measures (CBMs) can contribute to deterring diversion and/or theft of WMD assets. These CBMs can be applied either on-site or off-site and can consist of any combination of declarations, information exchange, audits, inspections, monitoring, and the like. The more frequent and intrusive the CBM, the more costly it is to implement and the more effectively it will deter diversion and/or theft of WMD assets.

Costs can include not only financial costs, but also the loss of national security owing to the disclosure of commercial, proprietary, and/or classified information through implementing the CBMs. There can also be costs associated with environmental, safety, and health (ES&H) risks, that depend upon the CBMs applied and the retirement and conversion technologies selected.

The benefits of disarmament arms-control agreements can include the reduction of the risk of diversion and/or theft, as measured by a security PRA. The frequency of diversion and/or theft decreases as the attractiveness of the asset is diminished by, say, a conversion technology. Other benefits include transparency (the willingness to cooperate and the degree of understanding) afforded by the CBMs, the probability of detecting diversion and/or theft, and the timeliness of implementing the retirement and conversion technologies.

The costs and the benefits represent attributes, the value of which may be regarded quite differently in the eyes of the various arms-control stakeholders. Within each nation party to a disarmament agreement, there are various public and governmental stakeholders that have a vested interest in the outcome of an agreement. These stakeholders can have a very special, focused interest in only limited aspects of the cost and benefit attributes. For example, a municipal government or public interest group may be much more concerned about ES&H risk than say a federal government agency that may be quite concerned about risks of diversion and/or theft of WMD assets. These differing values are natural and appropriate and can be captured in a formal way by eliciting the tradeoff preferences of each of the stakeholders.

Multiattribute utility analysis is ideally suited for quantifying stakeholder preferences for different attributes, which in this case are the costs and benefits. It is possible to find an optimal protocol for any stakeholder, comprised of a set of retirement and conversion technologies, safeguards and security measures, and associated CBMs (including the extent to which they are applied) for which the benefit-cost ratio (BCR) is maximal. Optimal, consensus protocols can be investigated by examining protocols that offer the largest minimum BCR among all of the stakeholders.

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